Acousto-optics effects in photonic crystals

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The effect of a time-varying modulation of the periodic potential of a photonic crystal is investigated. The theory rests on a recent description of the chirped photonic crystal modes in terms of energy carriers [1] accelerated by refractive index gradients.

The time-evolution of the scalar envelope function describing the photonic carrier dynamics is derived from time-dependent Maxwell's equations. Long-range, slowly-varying, refractive index changes caused by a high-intensity ultrasonic wave launched in a piezoelectric structure are assumed.

The theory is applied to a one-dimensional stack of "1-3" piezoelectric materials, with the "1" axis oriented perpendicular to the layers. A monochromatic incident light beam, polarized along the "3" axis is incident on the structure, resulting in "1"-axis mechanical compression. The transmission of this stack is studied for a range of frequencies which encompass a 1D stop-band. From these, the probability of absorption and emission of acoustic power, leading to photonic carrier interband transitions and a corresponding change of light frequency, is investigated. The possible use of these effects for the determination of electro-mechanical coupling coefficients is discussed.

[1] V. Lousse and J.P. Vigneron, this conference.